



INL operates an expansive power grid test bed for government, industry and academic research

Electric Grid Security Capabilities

The nation's electric power grid consists of thousands of miles of high-voltage power lines, substations and distribution transformers, and millions of miles of low-voltage power lines providing electricity to homes, businesses and communities. Industrial control systems are at the heart of this network, controlling the flow of power and regulating safety and reliability.

Utilities rely on these systems to gather and communicate data on grid processes and operations and send control commands to field connected devices controlling the flow of electricity. But as the power grid has evolved and new technology has been introduced, cybersecurity vulnerabilities in control systems and related operational technology are an increasing concern to national security.

ELECTRIC GRID TEST BED

To safeguard the public and support the Department of Energy's (DOE) mission to ensure our energy delivery is secure, resilient and reliable, Idaho National Laboratory operates a utility-scale electric grid test bed. The test bed is an operational, commercially fed system that provides power to INL's key research facilities across its sprawling 890-square mile desert Site. The test bed includes: seven substations, a control center, 61 miles of 138kV transmission lines and multiple distribution circuits at 15kV, 25kV and 35kV.

Sections of the grid can be isolated and reconfigured for integrated testing and demonstration of state-of-the-art power systems, components and smart grid technologies. Recently completed enhancements to the test bed allow 65% of U.S. distribution class

voltages to be represented alongside additional fiber connectivity, instrumentation and SmartGrid interface test points. The test bed's loop-fed substations are linked with modern Supervisory Control and Data Acquisition (SCADA) systems and a dedicated fiber-optic communication network.

The electric grid test bed is operated under a full range of climatic conditions including temperature range, wind, snow and ice that mirror national grid conditions. Coupled with robust power systems engineering and modeling and analysis capabilities, INL's test grid supports power quality and phenomenology studies associated with new equipment and system operations; high fidelity measurement systems that capture transients, harmonics, voltage and current; and the development and





full-scale testing of smart technologies and smart devices including testing for interoperability, operational performance, reliability and resiliency contribution. These capabilities collectively represent a rare resource across the DOE lab complex.

TESTING ACTIVITIES

INL's electric grid test bed has been used to validate and demonstrate the effects of threats including Geo-Magnetic Disturbances (GMD). Work is also underway with several DOE offices that will utilize the test grid to validate select protective relay security methodologies and demonstrate, at scale, the effects certain classes of cyber exploits could have on critical grid operations.

In addition, INL owns and operates several more test beds and research facilities

that collectively represent an environment like a small urban city. These test beds include testing and training space in control systems cybersecurity, wireless technology, water security, explosives and energetics, transportation systems, unmanned aerial vehicles, modeling and simulation, and radiological materials detection.

As a world leader in control systems cybersecurity, INL has more than 100,000 square feet of laboratory and electronics testing space for analyzing and testing industrial control systems and other relevant technology including programmable logic controllers, remote terminal units, digital relays and energy management systems. These labs are enhanced by employees

with dedicated expertise in operational technology cybersecurity, power systems engineering and vulnerability analysis. The lab's control systems test beds can be connected directly to INL's grid, creating a full-scale test and evaluation environment.

FUTURE ENHANCEMENTS

In 2019, INL received approval from DOE to expand its power grid transmission and distribution network with an additional 16.5 miles of 138kV transmission line, equipment laydown areas, and new test pads for research and equipment testing. This new line will be dedicated solely to conducting full-scale test experiments involving equipment such as diesel generators, transformers, gas-filled circuit breakers, switchgear, load banks, instrumentation and battery trailers. The expansion will also involve upgrades and modifications to one substation and control room additions.

FOR MORE INFORMATION

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1. INL's electric grid security capabilities include staff expertise, laboratory space and a full-scale test bed complete with modern commercial infrastructure.
2. The electric grid test bed is located on the laboratory's 890-square mile Site inside the dedicated Critical Infrastructure Test Range Complex (CITRC).
3. The electric grid test bed is one of several testing environments capable of supporting government, military and industry customers with full-scale research, testing and training services.
4. INL has extensive relationships throughout government, academia and private industry supporting collaborative approaches to power grid security and control systems cybersecurity.

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